What we know and don't know about invasive vertebrates in Europe

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Introduction

Invasive species are those that have been introduced to regions beyond their native range, established in the wild, and spread substantially from their point of introduction (Blackburn et al., 2009; Lockwood et al., 2007). They can diminish biodiversity, introduce diseases, and cause further ecological problems and economic costs (Kettunen et al. 2009). Although a few early publications about invasive species date back to the 19th century (Darwin, 1859; reviewed in Cadotte, 2006), publications have only become numerous since the late 20th century (Richardson and Pyšek, 2008). Many hypotheses about invasive species have been proposed, but only recently has it become possible to test them adequately, as sufficient studies and data were not available before. A prominent example for a project that collected data on invaders in Europe is DAISIE (2009). With sufficient studies and data now available, invasion biology has entered a new stage where existing hypotheses can be rigorously tested, and those that fail these tests may be modified or replaced. Another challenge that invasion biology is currently facing is the need to build bridges with related disciplines (Davis, 2009). To illustrate these challenges and their implications for invasive species management (Clout and Williams, 2009), I outline to what degree we can currently answer the following questions, which have guided research on invasive species for decades (Drake et al., 1989): (1) How many species become invasive in a given region? (2) Which species become invasive? (3) Which regions are especially susceptible to invasive species? I will focus on invasive vertebrates in Europe, but for comparison, I will also mention other taxonomic groups and continents.

Keywords: biotic resistance hypothesis, exotic species, fast life histories, invasion biology, non-native species, propagule pressure, tens rule

How many species become invasive in a given region?

If policy makers are faced with the question whether or not to invest in border controls against accidental species introductions, they need to know what fraction of introduced species will become invasive. This fraction can then be used to parameterize cost-benefit models. A hypothesis that predicts this fraction is the tens rule, which says that of 100 introduced species, about 10 will establish themselves and 1 will become invasive (Williamson, 1996; Williamson and Brown, 1986). Recent studies, however, suggest that this hypothesis lacks empirical support, especially for vertebrates (Jeschke, 2008; Jeschke and Strayer, 2005).

Which species become invasive?

If a company plans to introduce a vertebrate species, e.g. for food production, it would be helpful to have a probability estimate that this species will become invasive. Having this goal in mind, invasion biologists are looking for the characteristics of invasive species that discriminate them from other species. There are many hypotheses about the characteristics of invasive species. A classical hypothesis says that species with a fast life history are more often invasive than species with a slow life history, i.e. invasive species tend to reproduce early, have a high fecundity, and a short lifespan (Lodge, 1993). Among mammals and birds, species with larger brains are supposedly more successful in invading new environments, due to their supposedly higher behavioural flexibility (Sol and Lefebvre, 2000; Sol et al., 2008). Besides these rather species-specific traits, there are also traits that characterize the association of species with humans and that also potentially influence invasiveness. Such traits were largely ignored in early studies on biological invasions but are now in the focus of many researchers. One such trait is propagule pressure, a composite trait that reflects how often individuals of a given species are introduced to a given region, and how many individuals are introduced each time (Blackburn et al., 2009; Lockwood et al., 2005). Recent studies about invasive vertebrates suggest that propagule pressure and other traits

characterizing their association with humans are stronger determinants of invasiveness than life-history traits, brain size, and other species-specific traits (e.g. Jeschke and Strayer, 2006).

Which regions are especially susceptible to invasive species?

Comparing different regions, e.g. different European countries, it is apparent that some regions host more invasive species than others. The classic idea to explain these differences is the biotic resistance hypothesis which says that regions with relatively low biodiversity and high human impact are more susceptible to invasions than regions with relatively high biodiversity and low human impact (Elton, 1958). However, recent studies of invasive vertebrates do not support this hypothesis (Chiron et al., 2009; Jeschke and Genovesi, 2011; Leprieur et al., 2008).

Conclusions

Many hypotheses about invasive vertebrates and other invaders lack empirical support. They are thus potentially misleading when designing management strategies against invaders. It is time to revise these hypotheses.

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